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## ACTINOMYCOSIS, OR LUMPY JAW.<sup>a</sup>

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[Revised by D. E. Salmon, D. V. M., and John R. Mohler, V. M. D.]

### CAUSE OF THE DISEASE.

Actinomycosis, also known as lumpy jaw, big jaw, wooden tongue, etc., is a chronic infectious disease characterized by the formation of peculiar tumors in various regions of the body, more particularly the head, and due to the specific action of a certain fungus (actinomyces). This fungus is an organism which occurs in the tissues in the form of rosettes, and it has therefore been termed the "ray fungus." The disease is not directly transmitted from one animal to another, but it seems apparent that the fungus is conveyed into the tissues by various foodstuffs through slight wounds of the mucous membrane of the mouth, decayed teeth, or during the shedding of milk teeth. The ray fungus is found in nature vegetated on grasses, on the awns of barley, the spears of oats, and on other grains. Quantities of the fungi have been found between vegetable fibers of barley which had penetrated the gums of cattle and on the awns of grain embedded in the tongues of cows.

Although actinomycotic tumors on cattle had been the object of study for many years, it was not until 1877 that the constant presence of actinomyces was pointed out by Bollinger, of Munich, and since that time they have been considered the cause. This fungus had been observed in these tumors as early as 1860 by Rivolta, and by others subsequently, without having been suspected as causing them.

Since Bollinger's publication a large amount of work has been done, many observations have been made, and many hitherto obscure disease processes brought into relation with this fungus. Furthermore, a

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<sup>a</sup>Reprinted (with slight revision) from Special Report on Diseases of Cattle, 1904: This circular supersedes Bureau of Animal Industry Circular No. 7 on the same subject.

similar disease in man was first definitely shown to be associated with the same fungus in 1878 by Israel, and in the following year Ponfick pointed out that the disease described by Bollinger in animals and that found by Israel in man were due to the same cause—that is, that the fungi described by these observers were one and the same.

The tumors and abscesses wherever they may be situated are all found to be the same in origin by the presence of the actinomyces fungus. When they are incised, a very close scrutiny with the naked eye, or at most a hand lens, will reveal the presence of minute grains which vary from a pale-yellow to a sulphur-yellow color. They may be very abundant or so few as to be overlooked. They are embedded in the soft tissue composing the tumor or in the pus of the abscess. With a needle they are easily lifted out from the tissue, and then they appear as roundish masses about one-half millimeter ( $\frac{1}{60}$  inch) in diameter.

These are the bodies whose presence causes sufficient irritation in the tissues into which they find their way to set up inflammatory growths. These growths increase as the fungus continues to multiply until they reach enormous dimensions, if the affected animal is permitted to live long enough. The true nature of this parasite is not yet definitely settled, although many excellent observers have occupied themselves with it. According to earlier observers it is a true fungus. Later ones are inclined to place it among the higher bacteria. Further investigations will be necessary to clear up this subject.

Whatever be the situation of the disease caused by actinomyces, its nature is fundamentally the same and peculiar to the fungus. The pathological details which make this statement clear can not be entered upon in this place, nor would they be of any practical value to the farmer. We will simply dwell upon a few obvious characters.

The consistency of the tumor varies in different situations according to the quantity of fibrous or connective tissue present. When very little of this is present the tumor is of a very soft consistency. As the quantity of connective tissue is increased the tumor is firmer and of a more honeycombed appearance. The individual actinomyces colonies are lodged in the spaces or interstices formed by the meshwork of the connective tissue. There they are surrounded by a mantle of cellular elements which fill up the spaces. By scraping the cut surface of such a tumor these cell masses inclosing the fungi come away, and the latter may be seen as pale-yellow or sulphur-yellow specks, as described above.

#### LOCATION AND DESCRIPTION.

In cattle the disease process may be located both externally, where it is readily detected, and in internal organs. Its preferred seat is on the bones of the lower and upper jaw, in the parotid salivary gland in

the angle of the jaw, and in the region of the throat. It may also appear under the skin in different parts of the body. Internally it may attack the tongue and appear in the form of a tumor in the mouth, pharynx, and larynx. It may cause extensive disease of the lungs, more rarely of the digestive tract.

It appears, furthermore, that in certain districts or countries the disease seems to attack, by preference, certain parts. Thus in England actinomycosis of the tongue is most prevalent. In Denmark the soft parts of the head are most prone to disease, while in Russia the lips are the usual seat. In certain parts of Germany actinomycotic tumors of the throat (pharynx), in others disease of the jawbones, is most frequently encountered.

When the disease attacks the soft parts of the head a rather firm swelling appears, in which are formed one or more smaller projecting tumors, varying from the size of a nut to that of an egg. These push their way outward and finally break through the skin as small, reddish, funguslike bodies covered with thin sloughs. Or the original swelling, in place of enlarging in the manner described, may become transformed into an abscess which finally bursts to discharge creamy pus. The abscess cavity, however, does not disappear, but is soon filled with funguslike growths which force their way outward through the opening.

When the tumors are situated within the cavity of the pharynx they have broken through from some gland, perhaps beneath the mucous membrane, where the disease first appeared, and hang or project into the cavity of the pharynx either as pendulous masses with a slender stem or as tumors with a broad base. Their position may be such as to interfere with swallowing and with breathing. In either case serious symptoms will soon appear.

The invasion of the bones of the jaws by actinomycosis must be regarded as one of the most serious forms of the disease. It may start in the marrow of the bone and by a slow extension gradually cause it to become thickened and porous. The growth may continue outward, and after working its way through muscle and skin finally break through and appear externally as stinking fungoid growths. The growth may at the same time work its way inward and appear in the mouth. The disease may also begin in the periosteum, or covering of the bone, and destroy the bone from without inward. When the tongue is affected the animal finds it difficult to eat, the tongue is hard, inflexible, and swollen painfully, and in the advanced cases hangs from the mouth with abundant salivation, thus meriting the term "wooden tongue" applied to this condition.

Actinomycosis of the lungs is occasionally observed, and it is not improbable that it has been mistaken at times for tuberculosis. The actinomyces grains are, however, easily observed if the diseased tissue

be carefully examined. The changes in the lungs as they appear to the naked eye vary considerably from case to case. Thus, in one animal the lungs were affected as in ordinary broncho-pneumonia as to the location, extent, and appearance of the disease process. The affected lobes had a dark-red flesh appearance, with yellowish areas sprinkled in here and there. These latter areas were the seat of multiplication of the actinomyces fungus. In another case, of which only a small portion of the lungs was sent to the laboratory, these were completely transformed into a uniformly grayish mass, very soft, and pulpy to the touch, and appearing like very soft and moist dough. The actinomyces grains were exceedingly abundant in this tissue, and appeared when the tissue was incised as minute sulphur-yellow grains, densely sprinkled through the tissue, which readily came away and adhered to the knife blade. In still another case a portion of the lung tissue was converted into large, soft masses from 1 to 3 inches in diameter, each partly inclosed in very dense connective tissue. These soft, grayish-yellow masses likewise resembled moist dough in their consistency, and the actinomyces grains, though neither very distinct nor at all abundant, were easily fished out and identified as such. A portion of this growth, which was as large as a child's head, was converted into an abscess filled with creamy semiliquid pus.

This case differed from the preceding in that all appearance of lung tissue had disappeared from the diseased mass. Only on the exterior could the lung tissue be recognized, although even there it had been largely converted into very dense, whitish, connective tissue inclosing the fungoid growth. In the other case the external form of the lung and the shape and outline of the lobules were preserved, but the lung tissue itself was not recognizable as such. In the case first mentioned the changes were still less marked, and actinomycosis would not have been suspected by a simple inspection. These few illustrations suffice to show that actinomycosis of the lungs may appear under quite different forms, and that the nature of the disease can be accurately determined only by finding the fungus itself. Rarely actinomycosis attacks the body externally in places other than the head and neck. Crookshank describes the case of a bull in which the flank was attacked and subsequently the scrotum became diseased. A large portion of the skin of the flank was destroyed and covered with a leathery crust. When this was pulled away the pus beneath it showed the actinomyces grains to the naked eye.

Actinomycosis may also involve the udder, the spermatic cord of castrated animals, vagina, and, when it becomes generalized, the brain, liver, spleen, and muscular tissue.

Actinomycosis may in some cases be confounded with tuberculosis. The diagnosis does not offer any difficulties, since the presence of the actinomyces fungus at once removes any existing doubts. As has

already been intimated, these grains, simulating sulphur balls, are visible to the naked eye, and their nature is readily determined with the aid of a microscope.

The course of the disease is quite slow. As the tumors grow they may interfere with the natural functions of the body. According to their situation, mastication, rumination, or breathing may be interfered with, and in this way the animal may become emaciated. Actinomycosis of the jawbones leads to the destruction of the teeth and impedes the movements necessary to chewing the food. Similarly, when the disease attacks the soft parts of the head obstructions may arise in the mouth by an inward growth of the tumor. If tumors exist in the pharynx they may partially obstruct the movements necessary to breathing, or close the air passages and cause partial suffocation. Actinomycosis of the tongue, in interfering with the many and varied movements of this important organ, is also a serious matter. There is no reason to suppose that the localized disease interferes with the general health in any other way than indirectly until internal organs, such as the lungs, become involved.

A very small proportion of the cases may recover spontaneously, the tumors being encysted or undergoing calcification. In most cases the disease yields readily to proper treatment, and about 75 per cent of the affected animals may be cured.

#### PREVENTION.

The question as to how and where animals take this disease is one concerning which we are still in the stage of conjecture, because we possess as yet very little information concerning the life history of the actinomyces itself. The quite unanimous view of all observers is that animals become infected from the food. The fungus is lodged upon the plants and in some way enters the tissues of the head, the lungs, and the digestive tract, where it sets up its peculiar activity. It is likewise generally believed that the fungus is, as it were, inoculated into the affected part. This inoculation is performed by the sharp and pointed parts of plants which penetrate the mucous membrane and carry with them the fungus. The disease is therefore inoculable rather than contagious. The mere presence of the diseased animal will not give rise to disease in healthy animals unless the actinomyces grains pass directly from the diseased into some wound or abrasion of the healthy or else drop upon the food which is consumed by the healthy. Not only are these views deducible from clinical observation, but they have been proved by the positive inoculation of calves and smaller animals with actinomyces. The danger, therefore, of the presence of actinomyces for healthy animals is a limited one. Nevertheless an animal affected with this disease should not be allowed to go at large.

or run with other animals. If the fungus is being scattered by discharging growths we certainly can not state at this stage of our knowledge that other animals may not be infected by such distribution, and we must assume, until more positive information is at hand, that this actually occurs.

It is, however, the opinion of the majority of authorities that when actinomycosis appears among a large number of animals they all contract it in the same way from the food. Much speculation has therefore arisen whether any particular plant or group of plants is the source of the infection and whether any special condition of the soil favors it. Very little positive information is at hand on these questions. It would be very desirable for those who live in localities where this disease is prevalent to make statistical and other observations on the occurrence of the disease with reference to the season of the year, the kind of food, the nature of the soil (whether swampy or dry, recently reclaimed or cultivated for a long time) upon which the animals are pastured or upon which the food is grown.

It is highly probable that such investigations will lead to an understanding of the source of the fungus and the means for checking the spread of the disease itself. Veterinarian Jensen, of Denmark, made some observations upon an extensive outbreak of actinomycosis a number of years ago, which led him to infer that the animals were inoculated by eating barley straw harvested from pieces of ground just reclaimed from the sea. While the animals remained unaffected as long as they pastured on this ground or ate the hay obtained from it, they became diseased after eating the straw of cereals from the same territory. Others have found that cattle grazing upon low pastures along the banks of streams and subject to inundations are more prone to the disease. It has also been observed that food gathered from such grounds may give rise to the disease even after prolonged drying. Actinomycosis is not infrequent in southwestern cattle and is generally supposed to be the result of eating the prickly fruit of the cactus plant, causing wounds of the mucous membrane and subsequent infection with the parasite. Much additional information of a similar kind must be forthcoming before the source and manner of infection in this disease and its dependence upon external conditions will be known. It is not at all improbable that these may vary considerably from place to place.

#### TREATMENT.

Until recently treatment has been almost entirely surgical. When the tumors are external and attached to soft parts only, an early removal may lead to recovery. This, of course, can only be undertaken by a trained veterinarian, especially as the various parts of the head and neck contain important vessels, nerves, and ducts which

should be injured as little as possible in any operation. Unless the tumor is completely removed it will reappear. Disease of the jaw-bones is at best a very serious matter, and treatment is likely to be of no avail.

In March, 1892, an important contribution to our knowledge of this subject was made by M. Nocard, of the Alfort Veterinary School, in a communication to the French Central Society of Veterinary Medicine. He showed clearly that the actinomycosis of the tongue, a disease which appears to be quite common in Germany, and is there known as "wooden tongue," could be quickly and permanently cured by the administration of iodide of potassium. M. Nocard calls attention to the success of M. Thomassen, of Utrecht, who recommended this treatment as long ago as 1885, and who has since treated more than eighty cases, all of which have been cured. A French veterinarian, M. Godbille, has treated a number of cases of actinomycosis in the tongue with the same remedy, all of which have been cured.

All of the cases referred to were of actinomycosis of the tongue, and no one appears to have attempted the cure of actinomycosis of the jaw until this was undertaken by Doctor Nørgaard, of the Bureau of Animal Industry. He selected a young steer in April, 1892, in fair condition, which had a tumor on the jaw measuring  $15\frac{1}{2}$  inches in circumference and from which a discharge had already been established. This animal was treated with iodide of potassium, and the result was a complete cure.

The iodide of potassium is given in doses of  $1\frac{1}{2}$  to  $2\frac{1}{2}$  drams once a day, dissolved in water, and administered as a drench. The dose should vary somewhat with the size of the animal and with the effects that are produced. If the dose is sufficiently large there appear signs of iodism in the course of a week or ten days. The skin becomes scurfy, there is a weeping from the eyes, catarrh of the nose, and loss of appetite. When these symptoms appear the medicine may be suspended for a few days and afterwards resumed in the same dose. The cure requires from three to six weeks' treatment. Some animals do not improve under treatment with iodide of potassium, and these are generally the ones which show no signs of iodism.

If there is no sign of improvement after the animals have been treated four or five weeks, and the medicine has been given in as large doses as appear desirable, it is an indication that the particular animal is not susceptible to the curative effects of the drug, and the treatment may therefore be abandoned.

It is not, however, advisable to administer iodide of potassium to milch cows, as it will considerably reduce the milk secretion or stop it altogether. Furthermore, a great part of the drug is excreted through the milk, making the milk unfit for use. It should not be given to animals in advanced pregnancy, as there is danger of producing abortion.



The best results are obtained by pushing the drug until you see its effect. The many tests to which this treatment has been subjected have proved with few exceptions its specific curative value. In addition to this the tumor should be painted externally with the tincture of iodine or Lugol's solution, or one of these solutions should be injected subcutaneously into the tumor.

M. Godbille has given as much as 4 drams of potassium iodide in one day to a steer, decreasing the dose one-fourth dram each day until the dose was  $1\frac{1}{4}$  drams, which was maintained until the twelfth day of treatment, when the steer appeared entirely cured.

M. Nocard gave the first day  $1\frac{1}{4}$  drams in one dose to a cow; the second and succeeding days a dose of 1 dram in the morning and evening, in each case before feeding. This treatment was continued for ten days, when the animal was cured.

#### ACTINOMYCOSIS AND THE PUBLIC HEALTH.

The interest which is shown concerning this cattle disease is largely due to the fact that the same disease attacks human beings. Its slow progress, its tendency to remain restricted to certain localities, and the absence of any directly contagious properties have thus far not aroused any anxiety in other countries as to its influence on the cattle industry, not even to the point of placing it among the infectious diseases of which statistics are annually published. Its possible bearing on public health has, however, given this disease a place in the public mind which it hardly deserves.

It has already been stated that the actinomyces fungus found in human disease is considered by authorities the same as that occurring in bovine affections. It is therefore of interest to conclude this article with a brief discussion of the disease in man and its relation to actinomycosis in cattle.

In man the location of the disease process corresponds fairly well with that in cattle. The majority of cases which have been reported in different parts of the world—and they are now quite numerous—indicate disease of the face. The skin, tongue, or the jawbones may become affected, and by a very slow process it may extend downward upon the neck and even into the cavity of the chest. In many cases the teeth have been found in a state of more or less advanced decay and ulceration. In a few cases disease of the lungs was observed without coexisting disease of the bones or soft parts of the head. In such cases the fungus must have been inhaled. The disease of the lungs after a time extends upon the chest wall. Here it may corrode the ribs and work its way through the muscles and the skin. An abscess is thus formed, discharging pus containing actinomyces grains. Disease of the digestive organs caused by this fungus has also been observed in a few instances.

Granting the identity of the disease in man and cattle, the question has been raised whether cattle are responsible for the disease in man. Any transmission of the infectious agent may be conceived of as taking place during the life of the animal and after slaughter from the meat. That human beings have contracted actinomycosis by coming in contact with diseased cattle is not shown by the cases that have hitherto been reported, for the occupations of most of the patients did not bring them into any relation whatever with cattle. While the possibility of such direct transmission is not denied, nevertheless it must be considered extremely rare. Practically the same position is maintained at present by most authorities as regards the transmission of the disease to man by eating meat. Israel, who has studied this question carefully, found the disease in Jews who never ate pork<sup>a</sup> and who likewise were protected by the rigorous meat inspection practiced by their sect from bovine actinomycosis. Furthermore, it must be borne in mind that actinomycosis is a local disease, causing great destruction of tissue where the fungus multiplies, but very rarely becoming generally disseminated over the body from the original disease focus. The fungus is only found in places where the disease process is manifest to the eye or becomes so in a very short time after the lodgment of the fungus. Only the greatest negligence would allow the actually diseased parts to be sold and consumed. Finally, this parasite, like all others, would be destroyed in the process of cooking. The majority of authorities thus do not believe that actinomycosis in man is directly traceable to the disease in animals, but are of the opinion that both man and animals are infected from a third source. This source has already been discussed above. How far these views may be modified by further and more telling investigations of the parasitic fungus itself no one can predict. There are still wide gaps in our knowledge, and the above presentation simply summarizes the prevailing views, to which there are, of course, dissenters. An attempt to give the views of both sides on this question would necessitate the summarizing and impartial discussion of all the experiments thus far made—a task entirely beyond the scope of the present work.

Whether an animal affected with actinomycosis should be used for human food after all diseased organs and tissues have been thoroughly removed is a question the answer to which depends on a variety of circumstances. Among these may be mentioned the thoroughness of the meat inspection itself, which allows no really diseased animal to pass muster, the extent of the disease, and the general condition of the animal affected.

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<sup>a</sup> Hogs are subject to actinomycosis.

removed depends upon the extent of the disease and the general condition of the animal affected. If the carcass is in a well-nourished condition and there is no evidence upon post-mortem examination that the disease has extended from a primary area of infection in the head, the carcass may be passed, but the head, including the tongue, should be condemned. If the carcass is in a well-nourished condition and the disease has extended beyond the primary area of infection, the carcass may be passed after destroying the affected parts, provided the lesions are slight, calcified, or encapsulated, and are confined to a single body cavity in addition to the original seat of infection. When, however, the general health of the animal is affected, or when there are more extensive areas or a larger number of centers of disease scattered throughout the body than above described, the carcass should be condemned as unfit for human food.

Approved:

JAMES WILSON,

*Secretary of Agriculture.*

WASHINGTON, D. C., *July 24, 1906.*

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